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THE ECHINOIDEA OF THE BUDA LIMESTONE

BY

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THE ECHINOIDEA OF THE BUDA LIMESTONE

By FRANCIS LUTHER WHITNEY

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Description of Species

SALENIIDÆ

Genus *Salenia*, Gray

Salenia volana, n. sp.

Plate I, figures 1–9

Dimensions.—Diameter at ambitus, 14 mm.; height, 8 mm.; apical disk, 9 mm.; peristome, 7 mm.

Description.—The test is subcircular in outline at the ambitus; abactinal surface gently convex, the sides inflated; actinal surface flat or moderately concave.

The ambulacral areas are narrow, slightly undulating at the abactinal ends, widening gradually from 1.5 mm. at the apical disk to 2 mm. at the peristome. Surface ornamented with 15 to 17 alternating, imperforate, mammillated, non-crenulate, longitudinally oval, primary tubercles. Situated between these on either side of the median line, especially in the region of the

peristome, are small granules. Smaller granules also encircle the plates. The pores are round, uniserial, and a little irregular in the region of the peristome.

The interambulacral areas are broader than the ambulacral being 4 mm. wide in the placogenous zone, 7 mm. in the median zone, and 3.75 mm. at the edge of the peristome. They consist of two rows of large, alternating plates, five in each row. The primary tubercles decrease gradually in size from the abactinal surface to the peristome where they are about as large as the tubercles of the ambulacra area. On each plate there is a prominent, crenulated boss bearing an imperforate mamelon surrounded by a large areola. Mammillated granules are so arranged around the margins of the plates that there are two on the upper adradial corners, while on the median margins of the plates there are from three to five. This is not an invariable distribution, for in the specimens studied, there is some change from area to area. There are miliaries between the tubercles of the adjoining plates along the median line. These are also found between the granules bordering the plates.

The peristome is large and circular. The basicoronal plates bear ten moderately deep branchial incisions. The interambulacral areas are straight between the incisions, and slightly broader than the ambulacral lips which are bilobate.

The periproct is elevated, subeliptical, the posterior side being nearly straight; the anterior, subangular.

The apical apparatus is large, circular, and slightly concave near the outer margins. It is composed of five ocular and five genital plates and one supernumerary plate, the suranal, which is at the center of the system. The right anterior genital plate has an incision of irregular form.

This species differs from *S. texana* Roemer in that it is not so elevated and has fewer ambulacral and interambulacral plates. The character of the interambulacral lips is also different, those of *S. texana* having two lobes whereas those in *S. volana* are straight. The periproct is also different in form. This species resembles *S. mexicana* Schlüter, but it is more depressed and has

only sixteen ambulacral tubercles whereas *S. mexicana* has twenty. The apical system is similar to that of *S. mexicana*, and has the right anterior genital plate incised in about the same manner. In the specimens studied, there are no ridges on the plates of the apical apparatus, but they were possibly eroded away although the specimen appears well preserved.

Salenia volana resembles *S. prestensis* Desor, but it has only five interambulacral plates whereas the European species has seven. The distribution of the granules is also different. Its general outline resembles that of *S. prestensis* more than that of *S. mexicana*. Considering the few important differences already mentioned, and the fact that *S. volana* occurs in the upper Cenomanian, whereas *S. prestensis* is from the Aptian and *S. mexicana* is from the Vraconian, it seems safe to regard it as a distinct species.

Since the above description was written, Dr. Böse has examined the type, and he believes that it is not the same as *S. mexicana* Schlüter.

Number of specimens: 6.

Occurrence: Lower division* of the Buda Limestone Shoal Creek, Austin; and Manchaca, Texas.

HEMICIDARIDÆ

Genus *Goniopygus*, Agassiz

Goniopygus budaensis, n. sp.

Plate II, figures 1–8

Dimensions.—Diameter at ambitus, 4.5 mm.; height, 2.25 mm.; apical disk, 3 mm.; peristome. 2.75 mm.

Description.—Test of small size, subconoidal; abactinal surface elevated; actinal surface flattened or concave.

The ambulacral areas gradually widen from the apical disk to the ambitus whence they decrease in width to the peristome. They are composed of 6–7 plates surmounted by mammillated, noncrenulated, imperforate tubercles which increase in size from the apical system to the ambitus, decreasing again toward the peristome. The pores are round, uniserial, and oblique.

*In the vicinity of Austin the Buda Limestone displays two distinct phases: a lower, chalky or marly, soft, white rock, and an upper, hard, yellowish to reddish rock.

The interambulacral areas are widest at the apical disk, and gradually decrease in size to the peristome. They are composed of 6–7 plates ornamented with mammillated, noncrenulated, imperforate tubercles which increase in size to the ambitus, decreasing again toward the peristome. Besides these primary tubercles, there are granules distributed about their bases and over the surface of the plates, but the specimens studied are not well enough preserved to make out their distribution.

The peristome is large, about .61 of the diameter of the test, decagonal and notched. The ambulacral and interambulacral lips are nearly equal and bilobate.

The apical system is prominent and elevated above the general surface of the test. It consists of five genital and five ocular plates. The genital plates are variable in form, the anterior plates being larger than the posterior plates. They are polygonal in outline and bounded by six or seven sides. The oculars are likewise somewhat variable in form and size. They are bounded by three long and two short sides. The surface of each genital plate is ornamented with a central depression containing a mamelon from which ridges radiate outward to the edges of the plate. The genital openings are at the edges of the plates where they join the corona. The periproct is subquadrangular and bordered by a raised collarette.

The specimens collected range in size from 4.5 mm. to about 9 mm. in diameter. They are not well preserved except in the smaller sizes. They occur most frequently at the base of the upper division of the Buda Limestone, but they range to the top and occur at the contact with the Eagle Ford. None has appeared yet in the lower division of the Buda, nor in the other divisions of the Washita series.

This species does not closely resemble any other described form of *Goniopygus*.

Number of specimens: 16.

Occurrence: Upper division of Buda Limestone, Austin, Texas.

CENTRECHINIDÆ

Genus *Codiopsis*, Agassiz

Codiopsis texana, n. sp.

Plate III, figures 1–4; Plate VI, figure 2

Dimensions.—Diameter, 27.75 mm.; height, 21.5 mm.; apical disk, about 11 mm.; peristome, 12 mm.

Description.—Test of medium size, elevated, subpentagonal in outline, the ambulacral areas being at the angles, while the interambulacral areas form the sides. The superior surface is inflated or domed, whereas the inferior surface is abruptly rounded from the ambitus to the peristome.

The ambulacral areas are prominent, nearly straight, inflated, and gradually tapering from a point at their junction with the oculars to the peristome where they are 5.5 mm. wide. Above the ambitus, there are only scattered tubercles or granules, but the surface is impressed by fine, longitudinal, undulating ridges giving it a shagreen appearance. Extending over about two-thirds of the distance from the peristome to the ambitus, there are two rows, of about seven each, of round, noncrenulate, imperforate, mammillated, alternating tubercles which decrease in size toward the peristome. Adradially of these, are two rows of small granules in each pore area. The row near the outer edge of the area has from three to eight granules, and is shorter than the more median row which extends nearly as far toward the ambitus as do the mammillated tubercles. Small granules encircle the areolas, and, associated with these are almost microscopic crenulations or warts which form a delicate wreath about the base of each scrobicule. Above the ambitus, the pores are both round and oval. Each pair of pores is located in a depression, surrounded by a peripodium, and arranged in arcs of three pairs to each ambulacral plate. Below the ambitus, the pore pairs increase in number till there are four rows at the peristome. In this region, the pores are more oblique than those above the ambitus, and emerge from the sides of a granule which separates the pores of each pair. Encircling each pore pair is a well developed rim which is interrupted opposite the pore nearest the peristome.

The interambulacral areas are large, depressed at the middle, and about three times as wide as the ambulacral areas. The surface above the ambitus is ornamented like that of the ambulacral areas. Below the ambitus, there are four rows of round,

noncrenulate, mammillated, imperforate tubercles diverging from the peristome in two rows on either half of the areas. In the adradial rows there are from 7 to 8 tubercles, while in the median rows there are from 4 to 5 tubercles. Each areola is bounded by a wreath of fine crenulations outside of which there is a circle of granules and warts.

The peristome is small, roughly pentagonal, and without notches. The ambulacral lips are twice the width of the interambulacral lips.

The apical system is flush with the surface of the test, and is composed of five genital and five ocular plates so intercalated with the coronal plates that it is difficult to distinguish them. The right anterior genital plate is larger than the others and is spongy, containing the madreporite. The genital pores are large and toward the outer ends of the plates. The surfaces of the other plates appear to have been marked with longitudinal ridges like those of the corona, but weathering has almost obliterated them. The ocular plates are irregular in form. Some appear pentagonal in outline while others do not, possibly owing to their state of preservation. The oculars are perforated toward their outer ends. The periproct is roughly pentagonal.

This species closely resembles *Codiopsis doma* Agassiz, but is not so elevated as that species and the sides are not so straight and the proportions are not the same. Comparison with a specimen from France indicates that the two are separate species, although very closely related.

Number of specimens: 1.

Occurrence: Top of lower division of Buda Limestone, Austin, Texas.

Cottaldia rotula Clark

Plate IV, figures 1–10; Plate V, figures 1–2

Dimensions.—Diameter, 24 mm.; height, 17.50 mm.; peristome, 3.5 mm.

Description.—Test of small or medium size, depressed, circular in outline, melon shaped, the narrow ambulacral areas standing slightly above the interambulacral areas.

The ambulacral areas are broadest at the ambitus, and their surfaces are ornamented with mammillated, crenulate, perforate tubercles arranged in transverse rows of two to three tubercles on each half of the ambulacrum, alternating with similar rows on the opposite half. This number may be reduced to one on each half ambulacrum in very small specimens. Around each couplet or triplet of tubercles there is a ring of granules. This ring does not seem entirely to close each areola, but shows only a tendency to do so between the tubercles.

The pores are round and uniserial or moderately arched and separated by granules. Below the ambitus, they become crowded and irregular.

The interambulacral areas are broad, being four or five times as wide as the ambulacral areas. The median portion is somewhat depressed, leaving the area in rounded, inflated halves. The surfaces of these areas are ornamented with alternating arched rows of mammillated, crenulate, perforated tubercles numbering from 3 to 11 on each half area. This number varies according to the age of the individual. In the small specimens, there appear to be only three tubercles, in each row, but in the larger ones the number increases to 10 or 11. This variability extends to the ambulacral areas as well, although the specimen figured in Plate IV, figure 7 shows a persistence in two tubercles to the row. This is a small individual considerably magnified in the figure. Encircling each areola is a ring of granules. These, and the granules on the ambulacral area, are so arranged that they appear at first sight as a double row of granules between the rows of tubercles. Toward the apical system and the peristome, the number of tubercles is reduced, and in the region of the peristome some crowding occurs.

The peristome is relatively small, decagonal, and notched. The ambulacral and interambulacral lips are straight, but the latter are about one-half of the width of the former, measured from notch to notch.

The apical system consists of five subtriangular genital plates and five V-shaped ocular plates so arranged that they form a

wreath like system. The genital plates are pierced centrally by large genital pores. The periproct is large and subpentagonal.

During its development this species undergoes considerable change in form and proportions as well as in ornamentation, as shown in the following table:

No. of specimen	Diam. mm.	Height mm.	Tubercles in each half Amb.	Tubercles in each half Iamb.
1	4.62	2.50	1–1	3–3
2	6.00	3.62	2–2	3–3
3	8.00	4.75	2–2	4–5
4	10.00	6.50	2–2	6–6
5	12.00	——	2–2	6–7
6	15.00	10.25	2 or 3–2 or 3	7–8
7	17.00	13.00	2 or 3–2 or 3	7–8
8	18.00	12.50	2 or 3–2 or 3	8–9
9	24.00	17.50	3–3	10–11

(*Measurements, across the area at the ambitus*)

Number of specimens: 11.

Occurrence: Both divisions of the Buda Limestone, Austin and Manchaca, Texas.

PHYMOSOMATIDÆ

Genus *Cyphosoma*, Agassiz

Cyphosoma volanum? Cragin

Plate VI, figure 1

Cyphosoma volanum Cragin, 1893, Geol. Survey Texas Fourth Annual Report, p. 147.

Cyphosoma volanum Cragin, 1894, Colorado Coll. Studies, Vol. 4, pp. 45, 47.

Cyphosoma volanum Hill, 1901, U. S. Geol. Survey Twenty-first Annual Report, pt. 7, p. 283.

Cyphosoma volanum Clark, 1915, U. S. Geol. Survey Monograph, Vol. LIV, p. 61, Pl. XXI, figs. 2a-b, 3.

Dimensions.—Diameter, 15 mm.; height, 6 mm.

Description.—Test circular, depressed, slightly elevated above the ambitus, concave below it.

Ambulacral areas narrow, broadest at the ambitus, pointed at the poles; ornamented with two rows of alternating, mammillated, crenluate, imperforate tubercles which are largest in the ambital region. Areolas bordered by granules so arranged that they form polygons with the largest granules at their angles;

number of plates, about 12.

Pores variable and in undulating rows which double above the ambitus near the apical system.

Interambulacral areas, double the width of the ambulacral at the ambitus; tubercles mammillated, crenulate, imperforate, and arranged in two rows on each half of the area. The areolas are bordered by granules forming polygons with extra large granules at the corners of the plates along the median and adradial lines.

Peristome and apical system unknown.

This is possibly the same as the species described by Cragin, but the specimen from the Buda Limestone is fragmentary and therefore unsatisfactory as a basis for determination and description.

Number of specimens: 1.

Occurrence: Upper division of the Buda Limestone, Austin, Texas.

PYGASTERIADÆ

Genus *Holectypus*, Desor

Holectypus planatus? Roemer

Plate VII, figures 1–5

Holectypus planatus Roemer, 1849, Texas, p. 393.

Holectypus planatus Roemer, 1852, Die Kreidebildungen von Texas, p. 84. Taf. X, fig. 2.

Holectypus planatus Shumard, 1852, Exploration Red River of Louisiana Rept. p. 211.

Holectypus planatus, Giebel, 1853, Naturwiss. Ver. in Halle Jahresb., p. 373.

Holectypus planatus Conrad, 1857, U. S. and Mex. Boundary Surv. Report, Vol. I, pt. 2, p. 145, Pl. I, fig. 4.

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Holectypus planatus Clark, 1891, Johns Hopkins Univ. Circ., Vol. 10, No. 87, p. 76.

Holectypus planatus Clark, 1893, Johns Hopkins Univ. Circ., Vol. 12, No. 103, p. 51.

Holectypus planatus Clark, 1893, U. S. Geol. Survey Bull. 97, pp. 51, 59. Pl. XXII, figs. 2a-i.

Holectypus planatus Cragin, 1893, Geol. Survey Texas Fourth Ann. Report pp. 159, 160.

Holectypus planatus Hill, 1901, U. S. Geol. Survey Twenty-first Ann. Report, pt. 7, p. 226.

Holectypus planatus Clark, 1915, U. S. Geol. Survey, Monograph, Vol. LIV, pp. 65, 66, Pl. XXV, figs. 2a-f, 3a-c, 4, Pl. XXVI, figs. 1a-e.

Dimensions.—Diameter, 14 mm.; height, 7.25 mm.; peristome, 4.5 mm.; apical system, 1.5 mm.

Description.—Test small, subcircular; upper surface elevated, inflated; lower surface flattened or concave toward the peristome.

The ambulacral areas are narrow, straight, widest at the ambitus, and somewhat lanceolate in form. There appear to be six rows of tubercles at the ambitus, but they decrease in number toward the peristome and apical disk.

The pores are uniserial, small, and round.

The interambulacral areas are a little more than twice as wide as the ambulacral areas. There are six rows of tubercles at the ambitus, but this number rapidly decreases toward the peristome and apical system.

The apical disk is small and regular in outline. It consists of five genital plates perforated by large genital pores, and five ocular plates. The madreporite is large and occupies the central portion of the system.

The peristome is a little less than one-third of the diameter of the test. It is slightly notched and decagonal in outline.

The periproct is oval and extends from the peristome to the outer margin of the test.

There are only two specimens at hand and they are so poorly preserved that it is very difficult to make a satisfactory determination or description of them. They probably belong to the species *H. planatus*, but there is some possibility that well preserved specimens would show that they do not.

Number of specimens: 4.

Occurrence: Buda Limestone, Austin, Texas.

NUCLEOLITIDÆ

Genus *Echinobrissus*, Breynius

Echinobrissus angustatus Clark

Plate VII, figures 6–9; Plate IX, figure 4

Echinobrissus angustatus Clark, 1915, U. S. Geol. Survey Monograph, Vol. LIV, p. 69, Plate XXVII, figs. 2a-c.

Dimensions.—Length, 15.5 mm.; width, 14 mm.; height, 8.5 mm.

Description.—Test small, subovate, rounded anteriorly, subquadrate and broadest posteriorly; upper surface elevated; apex anterior of the centre; lower surface concave.

The ambulacral areas are subpetaloid on the upper surface, simple toward the ambitus, and form a rudimentary floscelle near the peristome. The posterior ambulacra are the longest. Between the pore zones the areas are ornamented with two alternating rows of mammillated, perforate tubercles whose areolas are deeply sunken and surrounded by closely set granules.

The pores within the subpetaloid parts are arranged in pairs, the outer pores of which are oval whereas the inner ones are round. Here the pore pairs are separated by rows of fine granules, four to the row, within the pore zone itself. From the open ends of the subpetaloid parts the pores are fine and continue in diverging single rows to the ambitus. On the lower surface the pores again become paired and obliquely set in the floscelle.

The interambulacral areas are broad and ornamented with numerous tubercles surrounded by deeply sunken areolas. The spaces between these areolas are covered with fine granules.

The apical system is small. Four of the genital plates are pierced by large genital openings. The madreporite is large and centrally located.

The peristome is subpentagonal, sunken and ornamented with several rows of fine, closely set granules.

The periproct is oval, and situated at the anterior end of a deep groove.

Although the material described by Clark was too poor to serve as a basis of a satisfactory description, it appears to be the

same as that described above. In fact, the measurements agree with the material here selected, but the species attains a much larger size, e.g., length, 21 mm.; width, 19 mm.; height, 9.5 mm.

Number of specimens: 27.

Occurrence: Upper division of the Buda Limestone, Austin, Texas.

SPATANGIDÆ

Genus *Enallaster*, d'Orbigny

Enallaster traski, n. sp.

Plate VIII, figures 1–3

Dimensions.—Length, 40 mm.; width, 38 mm.; height, 20 mm. or more.

Description.—Test of medium size, suboval, widest part about midway of the length of the test; upper surface elevated, rising abruptly from the anterior margin, possibly highest in anterior, and gently sloping toward the posterior; anterior groove broad and forming a deep, wide notch in the anterior margin; posterior somewhat truncated; lower surface elevated in the region of the plastron, depressed about the peristome, giving rise to a keel-like form in the plastron.

The unpaired ambulacrum is in the anterior groove The pores consist of alternating elongate and rounded pore pairs. In the specimens studied, this alternation is not regular, for there are two pairs of elongate pores followed by a pair of round pores; then five pairs of elongate pores followed by a pair of round ones, which are, in turn, followed by three elongate pore pairs before another pair of round pores occurs. The area is not well enough preserved to follow out the complete series. The anterior paired ambulacral areas are flexuous. The pore zones are composed of an anterior zone of rounded pores and a posterior zone of round pores in the internal row and elongate pores in the external row. Five pairs of the posterior zone correspond to about seven pairs of the anterior zone.

The posterior ambulacral areas are much shorter than the others. Their pore zones consist of an anterior row of round pores separated from a posterior row of elongate pairs.

The surface of the test is covered with tubercles having broad areolas bordered by fine granules.

The peristome is small, transversely oval, and situated at the end of the first quarter of the length of the test.

The periproct is not preserved in the specimens studied.

The apical system is composed of four genital plates with large perforations, and five oculars. The right and left anterior genital plates are the largest, and approximate each other in size. The left anterior plate, however, unlike those of other species, narrows at its posterior end and extends backward throughout the entire apical system.

This species resembles *E. obliquatus* Clark, but it is more rounded in ambital outline and not so high. The anterior slope is also much steeper than in that species. It is more rounded than *E. mexicanus* Cotteau, and not so broad posteriorly.

I take pleasure in naming this species in honor of Mr. P. D. Trask, a student in Geology, whose interest and enthusiasm have led to several important discoveries concerning the fauna of the Buda Limestone.

Number of specimens: 2.

Occurrence: Buda Limestone, at base of upper division, Shoal Creek, Austin, Texas.

Enallaster bravoensis Böse

Plate VI, figures 3–5

Enallaster bravoensis Böse, 1910, Instituto Geol. de Mexico, Boletin 25, p. 168.

Lam, 41 Figs. 5–10; Lam. 42, figs. 2–12; Lam. 43, figs. 1–2, 6–7.

Dimensions.—Length, 38 mm.; width, 34 mm.; height, 21 mm.

Description.—Test of medium size, cordate, broadest anteriorly, truncated posteriorly; upper surface arched, the greatest elevation being between the apical system and the posterior border; unpaired interambulacrum with a slight crest. Forward from the apical system the test slopes rapidly; posteriorly, it remains high and is truncated; lower surface flattened, depressed about the peristome, and somewhat elevated posteriorly. The anterior groove is broad and deep, commencing in the apical system and extending forward around the ambitus, which it

notches, to the peristome.

The unpaired ambulacrum is situated in the anterior groove, and is wider than the other areas. Each pore zone is composed of eleven or more pairs of equal, rounded pores followed by a series of elongated, oblique pore pairs alternating with oval, oblique pores. This sequence continues for about two-thirds of the distance from the apical system to the ambitus. From this point the pores are in simple, oblique pairs to the peristome. The anterior paired ambulacra are not so long as the unpaired one, but they are nearly as wide. They are slightly flexuous, with the greatest curve at their posterior ends. The pores of their anterior zones are small, round, grouped in pairs, and variable in size. The posterior zone is much broader, and the pores of each pair are unequal, the internal ones being oval whereas the external pores are elongate. Seven pairs of the posterior zone correspond to about five pairs of the anterior zone. At the ends of the posterior zone, the pores become oval.

The posterior ambulacral areas are short and relatively broad. The pore zones are unequal, the anterior being narrower than the posterior, and composed of pairs of rounded pores. The pores of the posterior zone are elongate, the inner pores being a little shorter than the outer ones.

The tubercles are small, perforate, crenulate, and surrounded by broad areolas bordered by fine granules. The tubercles are largest in the interambulacral areas where they are associated with several fasciole-like bands of very fine granules. On the lower surface the tubercles are numerous, especially on the plastron.

The peristome is small, oval, and situated very near the anterior.

The periproct is rounded and situated in the upper part of the posterior truncation.

The apical system has four perforated genital plates, of which the two posterior are more separated than the anterior ones. Other details of the system are lacking in the specimen studied.

This species differs from *E. texanus* Roemer, in its form and dimensions, the position of its highest point, and the ratio of

the elongate pores to the rounded pores of the paired ambulacral areas. In *E. texanus* this ratio is four rounded pores to six elongate ones, whereas in *E. bravoensis* it is five to seven.

Number of specimens: 5.

Occurrence: Buda Limestone, Austin, Round Rock, and Manchaca, Texas.

Genus *Hemiaster*, Desor

Hemiaster calvini Clark

Plate VIII, figures 4–7; Plate IX, figures 1–3

Hemiaster calvini Clark, 1893, Johns Hopkins Univ. Cir., Vol. 12, No. 103, p. 52.

Hemiaster calvini Clark, 1893, U. S. Geol. Survey Bull. 97, pp. 90, 91, Pl. XLIX, figs. 2a-i.

Hemiaster calvini Böse, 1910, Instituto Geol. de Mexico Boletin 25, p. 175, Lam. 43, figs. 3–5, 8; Lam. 44, figs. 1–8, Lam. 45, figs. 1–3, 5.

Hemiaster calvini Clark, 1915, U. S. Geol. Survey Monograph, Vol. LIV, p. 91, Pl. XLVII, figs. 2a-i.

Dimensions.—Length, 31 mm.; width, 27.5 mm.; height, 22.00 mm.

Description.—Test of medium size, slightly polygonal in outline; upper surface elevated; lower surface flattened or slightly swollen in the region of the plastron; posterior truncated; ambulacra moderately and about equally depressed on the upper surface.

The unpaired ambulacrum is situated in a relatively broad and moderately deep groove beginning at the apex and extending forward to the ambitus which it notches slightly in passing around to the peristome. The pore zones are composed of pairs of small, oval, or nearly rounded, obliquely set pores. The pores of each pair are separated by a granule. This arrangement prevails half the distance from the beginning of the ambulacrum to the ambitus. Beyond this the pores are not so conspicuous, and continue to the peristome in widely separated pairs which are decidedly oblique.

The paired anterior ambulacral areas are broad, lanceolate, and situated in deep grooves. The pore zones are broad at their centres, but constricted at their ends. The pores of the

anterior and posterior zones are alike, and consist of pairs of small pores joined by line-like grooves. The space between the two zones is equal to the width of the zones. Beyond the petaloid parts the pores are continued as distant pairs of small, rounded, obliquely set pores which diverge rapidly toward the ambitus, but converge below it toward the peristome.

The posterior ambulacral areas are shorter than the others, and are situated in deep grooves. The pore zones are composed of pore pairs like those of the anterior areas. Beyond the petaloid parts, the pores are distant and minute on the upper surface, but closer together and larger on the lower surface.

The interambulacral areas are large and form crests about the apical system. Of these, the most prominent is the posterior crest. The lateral areas are divided into three distinct areas formed by two more or less prominent crests which extend from the apex to the ambitus. The surface of the test, with the exception of the petaloid parts, is covered with irregularly scattered tubercles.

The peristome is small, subpentagonal, and situated considerably anterior of the center.

The periproct is oval, and located in the upper part of the posterior truncation.

The fasciole is broad and prominent about the ends of the petaloid parts.

The apical system is of moderate size and located very slightly in advance of the center of the test. The genital pores are large, and so placed that the posterior ones are more separated than the anterior.

The madreporite is large and in the center of the system. The oculars are pentagonal.

Number of specimens: 6.

Occurrence: Buda Limestone, lower division, Austin and Manchaca, Texas.

EXPMANATION OF

PLATE 1 (15)

Salenia volana, n, sp. ..... Page 4 (88)

Fig's 1, 5, 9. Lateral surface of the test, enlarged.
6, 7. Lateral surface of the test.
2, 3. Upper surface of the test, enlarged.
8. Lower surface of the test, enlarged.
4. Ambulacral area, enlarged.

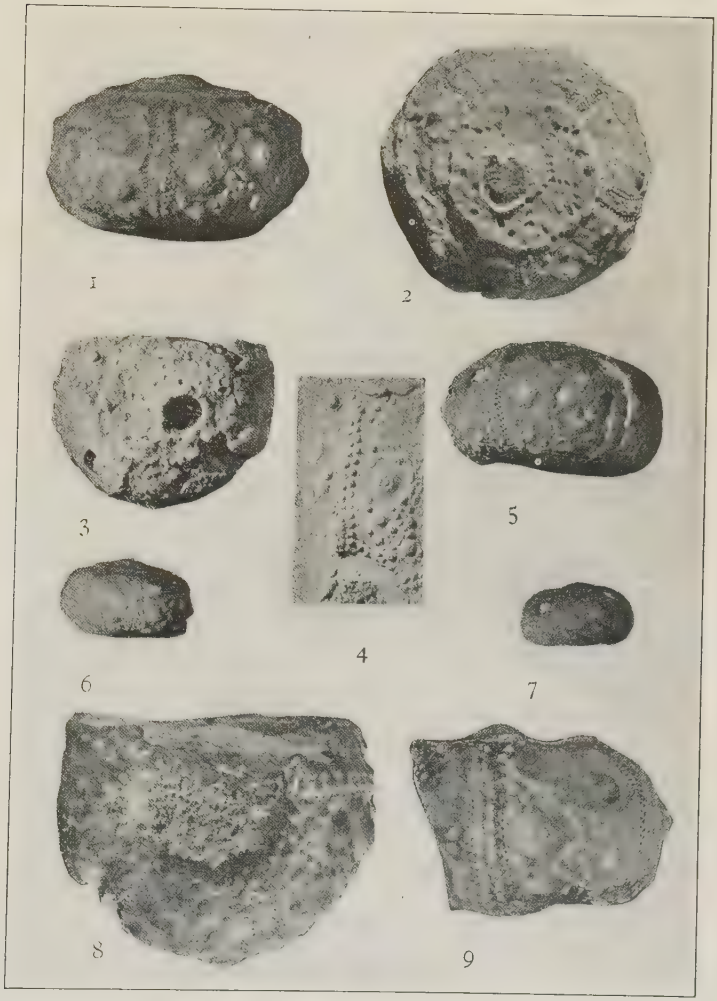
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Plate 2

EXPLANATION OF

PLATE 2 (16)

Goniopygus budæusis, n. sp..... Page 6 (90)

Fig. 1. Upper surface of the test, × 8.
2. Lower surface of the test, × 8.
3. Lateral surfrce of the test.
4. Lower surface of the test.
5, 6. Lateral surface of the test, enlarged.
7. Ambulacral area, enlarged.
8. Interambulacral area, enlarged.

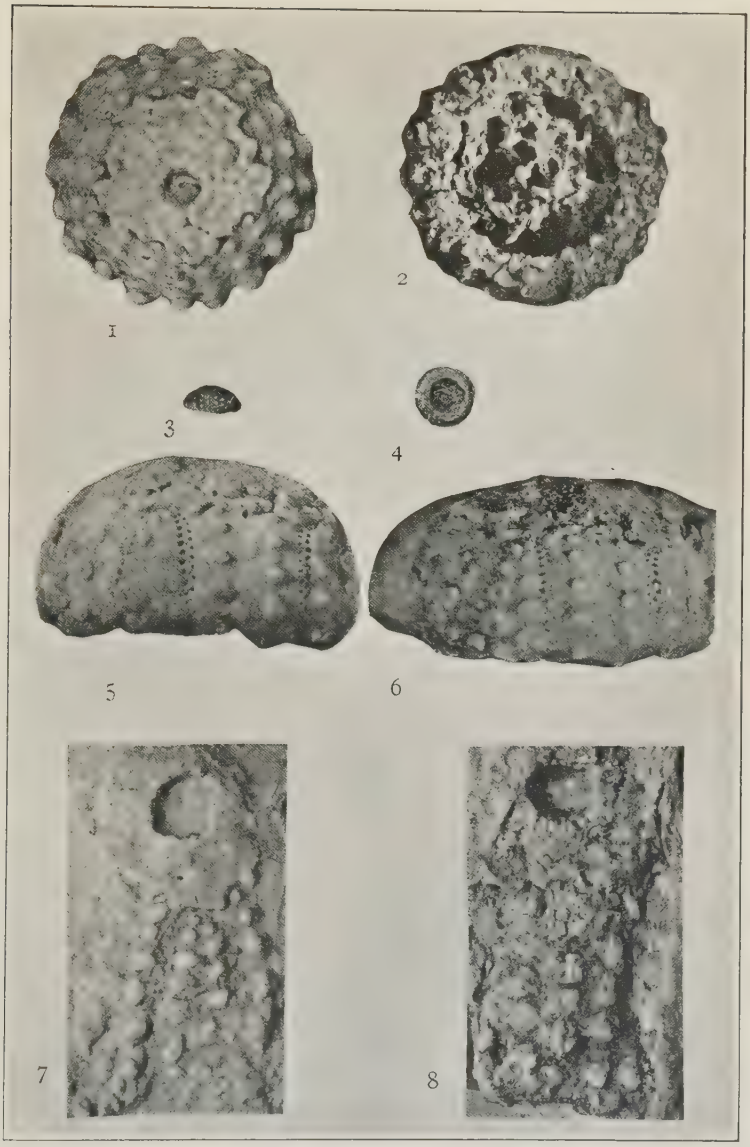
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Plate 3

EXPLANATION OF

PLATE 3 (17)

Codiopsis texana, n. sp., ... Page 7 (91)

Fig. 1. Upper surface of test.
2. Lateral surface of test.
3. Lateral surface of the test, ×2.
4. Lower surface of the test, ×2.

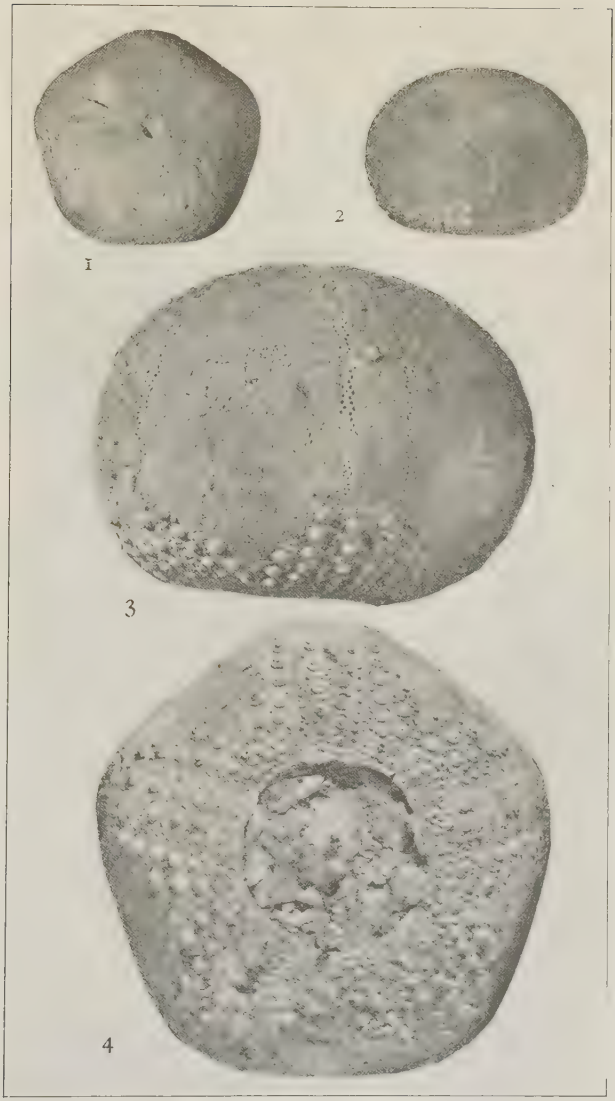
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Plate 4

EXPLANATION OF

PLATE 4 (18)

Cottaldia rotula, Clark..... Page 9 (93)

Fig. 1. Upper surface of the test, ×3.
2. Upper surface of the test of adult.
3. Lower surface of the test, ×4.
4. Lateral surface of the test, ×2.
5. Apical system, ×9.
6. Lateral surface of the test.
7. Lateral surface of the test, ×3.75.
8. Interambulacral area, enlarged.
9. Ambulacral area, enlarged.
10. Laterel surface of the test, ×7.

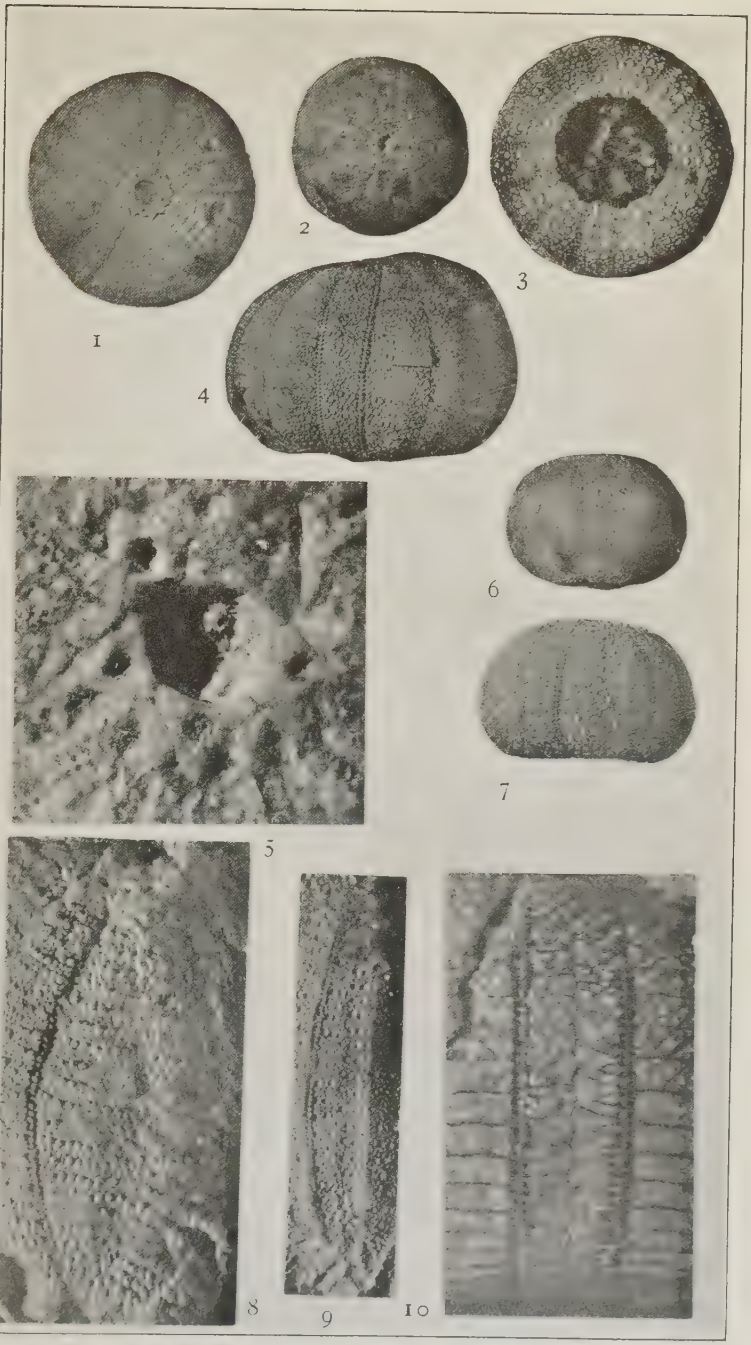
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Plate 5

EXPMANATION OF

PLATE 5 (19)

Cottaldia rotula, Clark..... Page 9 (93)

Fig. 1, (Above). Apical system, ×18.
2, (Below). Lateral surface of the test, ×32.

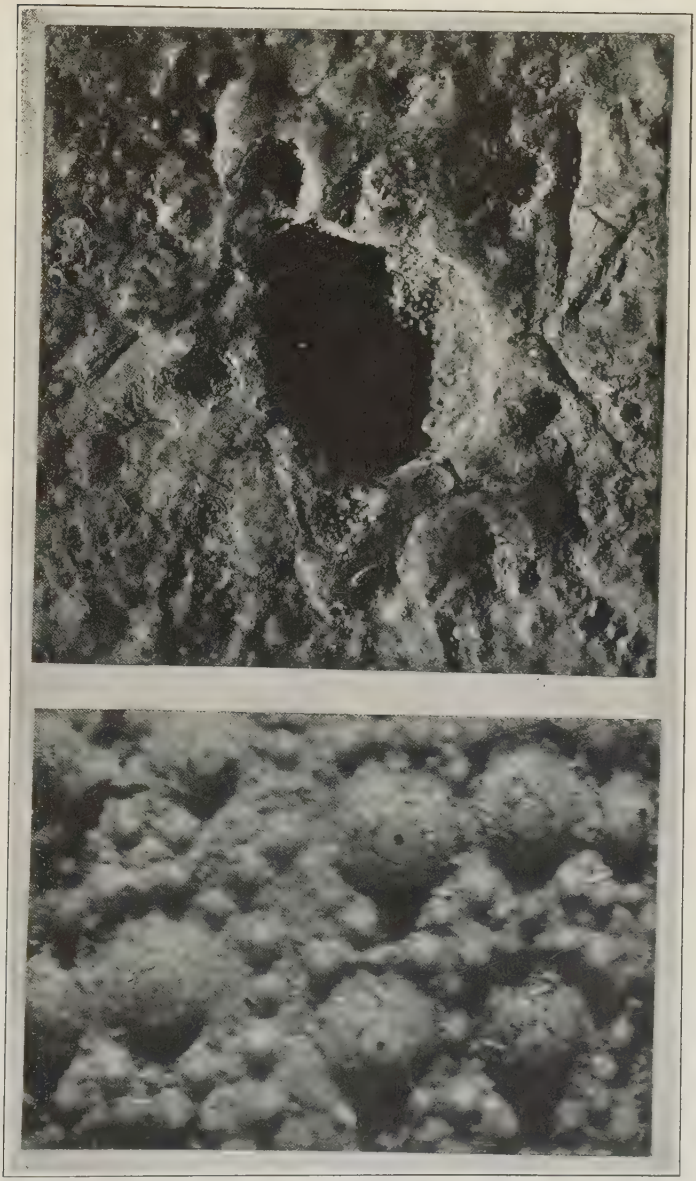

Plate 6

EXPLANATION OF

PLATE 6 (20)

Cyphosoma volanum ? Cragin, ... Page 11 (95)
Fig. 1. Lateral surface of the test.
Codiopsis texana, n. sp 7 (91)
Fig. 2. Apical system, enlarged.
Enallaster bravoensis Böse, ... 16 (100)
Fig. 3. Lateral surface of the test.
4. Upper surface of the test.
5. Lower surface of the test.

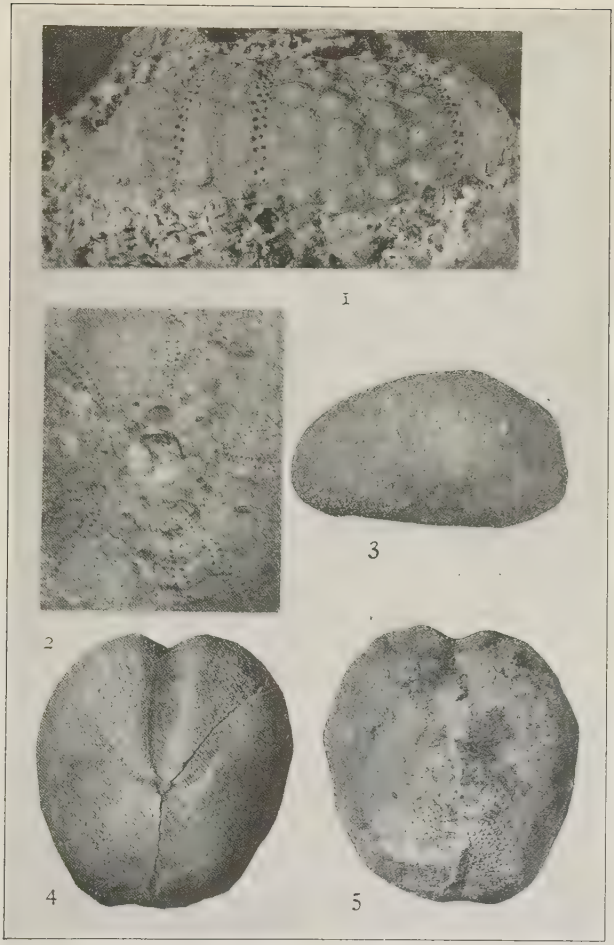
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Plate 7

EXPLANATION OF

PLATE 7 (21)

Holectypus planatus ? Roemer,..... Page 12 (96)

Fig. 1. Upper surface of the test, ×3.
2. Lower surface of the test, ×3.
3. Lateral surface of the test, ×4.
4. Lateral surface of the test.
5. Lower surface of the test of another specimen.

Echinobrissus angustatus Clark,..... 14 (98)

Fig. 6. Lateral surface of the test, ×2.75.
7. Upper surface of the test, ×2.
8. Upper surface of the test, ×3.
9. Lower surface of the test, ×3

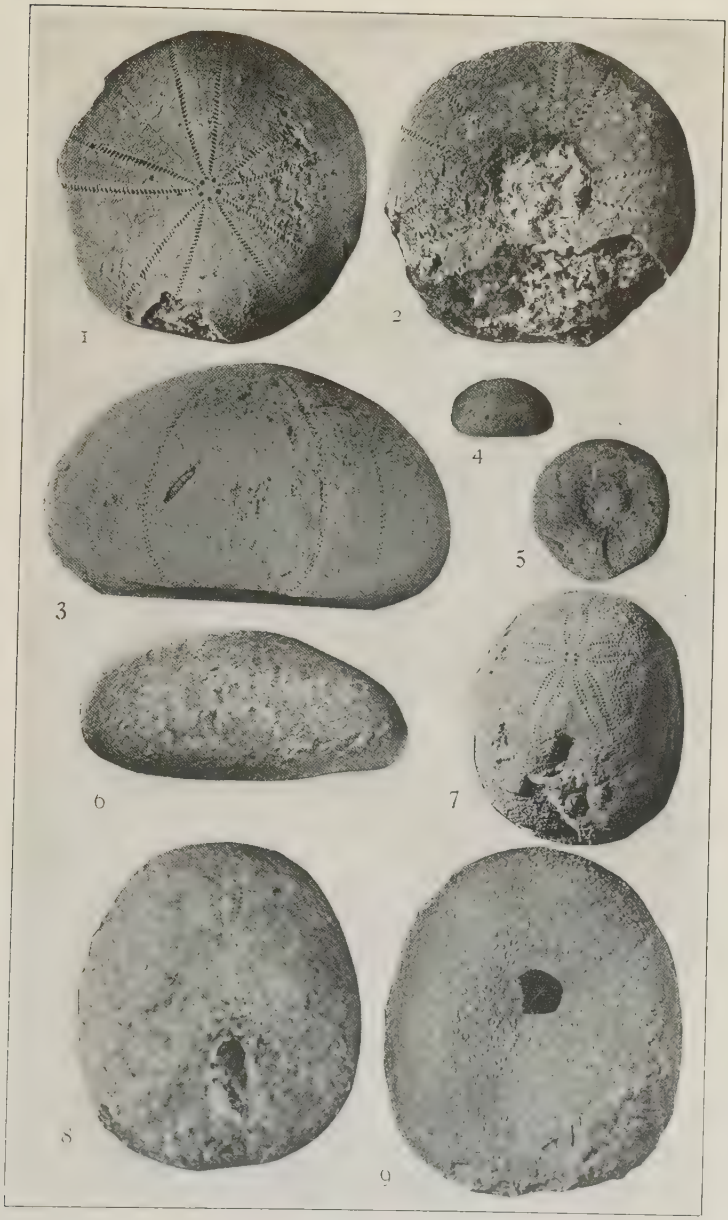
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Plate 8

EXPLANATION OF

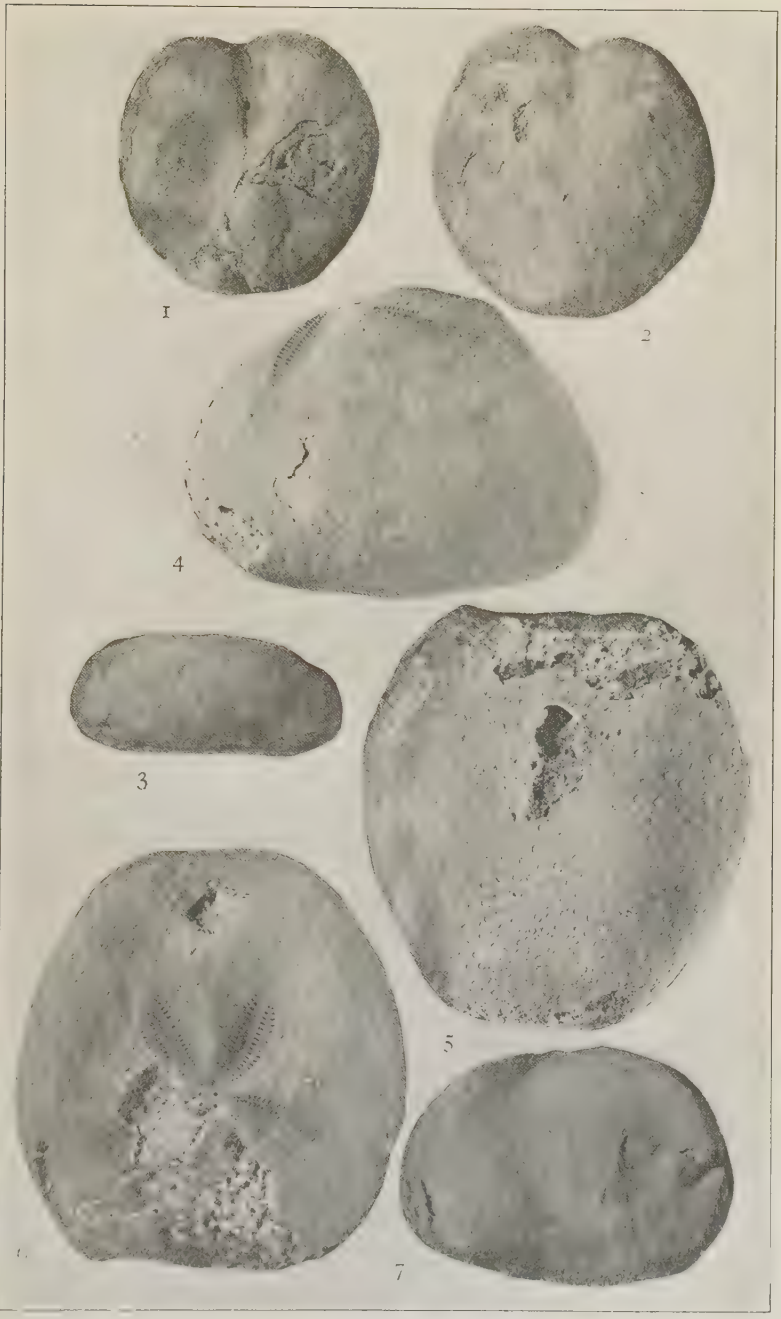
PLATE 8 (22)

Enallaster traski, n. sp. ..... Page 15 (99)

Fig. 1. Upper surface of the test.
2. Lower surface of the test.
3. Lateral surface of the test.

Hemiaster calvini Clark, ... 18 (102)

Fig. 4. Lateral surface of the test, ×3.
5. Lower surface of the test, ×3.
6. Upper surface of the test, ×3.
7. Lateral surface of the test, ×1.3.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EXPLANATION OF

PLATE 9 (23)

Hemiaster calvini, Clark,..... Page 18 (102)

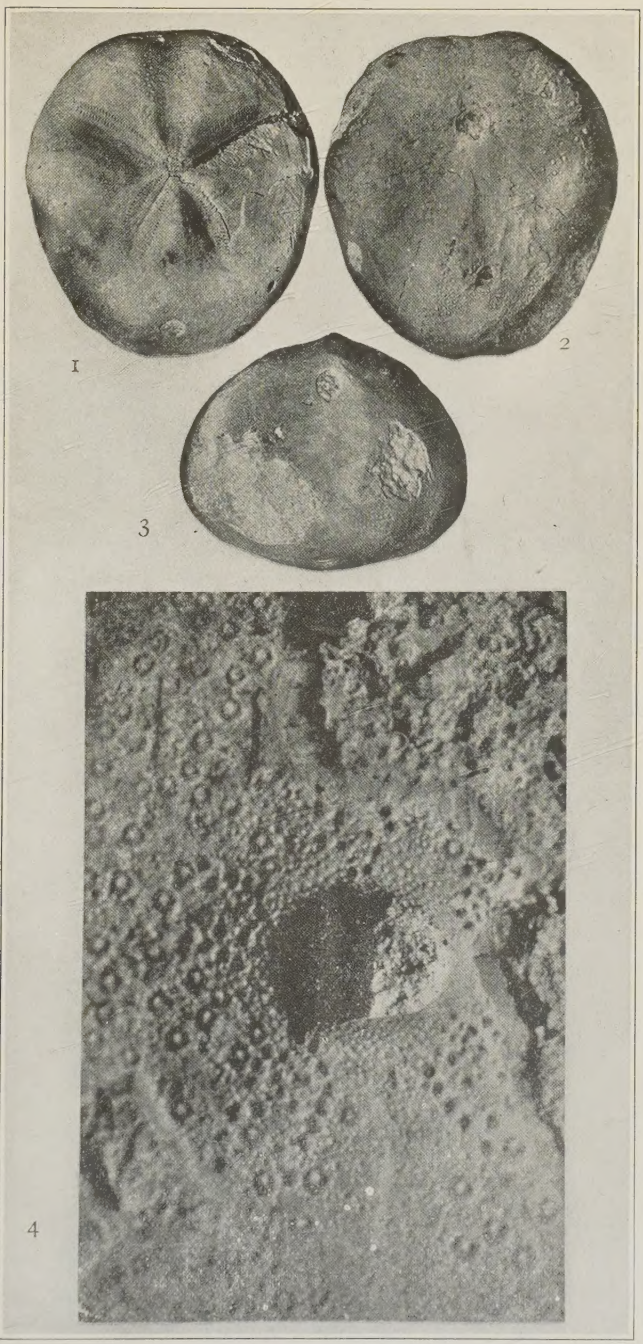
Fig. 1. Upper surface of the test, ×1.3.

2. Lower surface of the test, ×1.3.

3. Posterior surface of the test, ×1.3.

Echinobrissus angustatus Clark.

Fig. 4. Lower surface of the test, ×7.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